MINISTRY OF HEALTH

THE REHABILITATION OF AMPUTEES

General Principles drawn up by a Sub-Committee of
the Brussels Treaty Organisation
(now the Western European Union)

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Foreword

In 1953 the Brussels Treaty Organisation (now Western European Union) Joint Committee on the Rehabilitation and Resettlement of the Disabled set up a Sub-Committee under the Chairmanship of Dr. R. Langdale Kelham, O.B.E., F.R.C.S.,to study various aspects of the rehabilitation of amputees. The memorandum contained in the following pages was drawn up by the Sub-Committee and approved for publication by the Joint Committee.

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Introduction

THE WORKING PARTY ON ARTIFICIAL LIMBS of the Brussels Treaty Organisation comprising medical, technical and other delegates from Belgium, France, Luxembourg, the Netherlands and the United Kingdom, met first in Utrecht in February, 1953, in Paris in February, 1954, and finally in Luxembourg in October, 1954 to consider the many problems associated with the rehabilitation of the amputee.

It was recognised that under existing conditions many medical and paramedical workers were taking part in rehabilitation, but that co-ordination of activities was lacking, and further, that all were not working in accordance with any agreed basic principles.

During the period between amputation and re-entry into the normal life of the community, the amputee passes through a number of stages, each of which is closely inter-related with that which precedes and follows, and there should be no break in the continuity. Not only, therefore, should there be co-ordination of activities, but also a thorough understanding, on the part of all concerned, of the amputee problem.

The document which follows has been compiled with a view to indicating the broad general principles which should be followed in rehabilitating an amputee; it has been divided into two main parts for the purposes of simplicity and easy reference: General Principles and Appendices.

Appendices 1 and 2 give in considerable detail the type of exercises used in limb training. The exercises described, however, are merely examples of an exercise scheme, and should be treated as suggestions, being in no sense intended as binding regulations, since better exercises, better technique, and more suitable equipment will doubtless have been, or will be, developed.

Attached to the General Principles set out below are a number of appendices relating to

1. General Remedial Exercises
2. Walking Training Exercises
3. Surgical Technique of Amputation
4. Optimum Sites for Amputation
5. Minimum and Maximum Lengths of Stumps
6. Appliances
7. Research

GENERAL PRINCIPLES

I. The Parts Played by the Specialised Services in the Rehabilitation of the Amputee

(*a*) THE DOCTOR

The doctor who performs the amputation may, in some cases, supervise the remainder of the amputee's rehabilitation, or, in other cases, will place the patient under the care of a doctor specialising in post amputation treatment and prosthetic work.

In either case it is essential that the doctor undertaking the post amputation treatment shall have a detailed knowledge of all the various types of limbs available, their design, fitting, control and functional value, so that he is in a position to know the best type to suit the individual.

He should, further, be in a position to give the necessary instructions to nurses, physiotherapists and personnel concerned with amputees.

Therefore, practitioners about to undertake this work, whether as a whole-time speciality or in addition to their other medical activities, should have at least six months' intensive training.

In some cases, the services of a psychiatrist or psychologist might be necessary.

(*b*) THE NURSE

Student and graduate nurses who will attend upon amputees in hospitals require training in the particular requirements of the amputee in regard to position in bed, stump bandaging, and the steps necessary to render them independent in their activities as early as possible.

(*c*) PHYSIOTHERAPISTS

Student and graduate physiotherapists require training in the basic function and the designing of prostheses, sufficient to enable them to appreciate the reasons for the mobilisation of joints and re-development of certain muscles groups which will be called upon to activate the prosthesis. They should work under the supervision of the doctor.

(*d*) WALKING AND ARM TRAINING INSTRUCTORS

These should work under the direct supervision of the doctor. They require training as remedial gymnasts, and in addition should be given sufficient training in the fitting, design and function of prostheses to enable them to perform their duties with full understanding. They should be carefully selected for their personality, their ability to handle patients, using the correct sympathetic and mental approach thereto, and should thus not only teach, but inspire confidence and enthusiasm.

II. Immediate Post Operative Treatment

In addition to the usual treatment given after all surgical operations, it is advisable to consider the treatment needs which are peculiar to the amputee. These are (a) mental preparation, and (b) physical preparation.

1. MENTAL PREPARATION

All who undergo amputation suffer mental or psychological trauma to a greater or lesser degree. This trauma is exhibited in a number of ways. It may consist of depression, anxiety, fears regarding future mobility and enjoyment of life, fears of crippledom, and the fear of being unable to bear the burden of domestic and financial responsibilities.

Unless consideration be given to this aspect of the problem and the fears now present allayed as far as possible, physical rehabilitation alone cannot ensure complete success.

It is essential, therefore, that doctors and nurses in attendance upon amputees have a thorough understanding of the mental processes which may be affecting the patient; they should employ every means of allaying fears and giving hope and encouragement for the future. Patients should be informed at the earliest stage, even before amputation if possible, of the means which are about to be employed in restoring them to a useful life. Seeing amputees in a more advanced stage of rehabilitation than themselves is always beneficial, as is also an exhibition of films depicting the activities of the rehabilitated.

2. PHYSICAL PREPARATION

Position in bed

When a patient is returned to his bed after amputation of a lower limb, it is important to ensure that no contraction of the articulation of the hip or the knee is provoked or encouraged by the use of a pillow beneath the stump or the knee. The thigh stump should lie flat and the knee joint be extended.

Bandaging the stump

A special technique is recommended for bandaging the stump, designed to support it and compress the extremity, the tension being progressively increased in accordance with the patient's capacity to endure it. Crepe bandages are used, which should not be less than 4 inches (10 cm.) wide for arm stumps and amputations below the knee, and at least 6 inches (15 cm.) wide for thigh stumps. The bandages are worn day and night and should be redone at least four times a day. Nursing staff should be carefully trained to acquire this technique. The details regarding type and size of bandage and method described will doubtless be amended and improved upon as a result of the experience gained by those who practise it.

(*a*) *Bandaging the stump above the knee.* (See Plate II (*a*)–(*h*).) In bandaging a thigh stump the patient lies supine upon a couch and the free end of the bandage is placed upon the front of the stump as high up as the level of the inguinal ligament, being held in that position by the patient's two thumbs; the bandage is now drawn down caudally spread out to its full width with as much tension as the patient can bear down over the end of the stump and carried up behind to the level of the gluteal fold, being held in that position by the two forefingers of the patient. It is then brought down obliquely and externally over the stump's extremity, and up to the supporting point in front, thence down once more obliquely and internally over the extremity up to the gluteal fold again, being held by the patient's forefingers. The bandage is now twisted and a turn is made around the upper aspect of the stump as high as possible into the perineum, sufficient tension only being used in this turn to secure the upper extremities of the three slings.

The patient can now remove his hands. Next, the bandage is carried down to the stump's extremity, using increasing tension at that point and thence high up on the outer side to the buttock level. It is passed around the pelvis and back on to the stump making a spica turn. Care should be taken to ensure that the cross-over of the bandage is external and not anterior. From here the stump is again bandaged, using tension at the extremity, and then finished off.

It is important that the bandage be carried as high as possible into the perineum to avoid the appearance of a roll of flesh between it and the upper edge of the bandage.

As the bandage is carried upwards from the extremity, the tension should be diminished.

The system of bandaging as outlined above should not be continued after the initial oedema has become dispersed, especially when it is proposed to prescribe for the individual patient a suction or anatomically shaped socket.

(*b*) *Bandaging the stump in below-knee amputations.* (See Plate III (*a*)–(*c*).) When bandaging a below-knee stump a 4 inch (10 cm.) bandage of crepe is used. If the stump be bulky it may be necessary to use two bandages sewn together end to end. The method of applying the three initial slings is as already described, but corresponding to the spica turn around the waist, the bandage is carried round the lower end of the femur, just above the condyle, and back on to the stump again, leaving the patella and anterior aspect of the knee free and mobile.

III. Exercises for the Stump

I. LOWER LIMB

Some days after the amputation the patient should be encouraged to begin exercising the stump while still in bed. Exercises for thigh stumps consist of adduction and abduction and extension of the hip, which the patient performs prone in bed raising head and shoulders from the pillow. Exercises for stumps in below-knee amputations consist of exercises for the quadriceps. At the end of a few days the patient will practise the exercises against a gradually increasing resistance provided by the band of the assistant or nurse. Passive movements and massage are not recommended.

As soon as he is allowed up, the lower limb amputee will begin to use armpit crutches or elbow crutches. It is important that crutches should be of the desired length, because too short crutches have a tendency to produce a lordotic posture and also increase any tendency towards flexion of the hip, which frequently occurs because of the exaggerated movements of the ilio-psoas. The stump should always be kept bandaged when the patient is on crutches.

2. UPPER LIMB

As soon as possible after the amputation the patient is encouraged to make active movements of the shoulders, flexion, extension, abduction, carrying the movement through to its full extent. Forearm amputees should practise active movements of the elbow joint.

Particularly in the case of forearm amputees, the patient should be encouraged to make the greatest possible use of the stump. By attaching a spoon, fork or pencil, by means of a bandage, or an improvised leather gauntlet (see Plate III (*d*) and Plate IV (*a*)–(*c*)) built to hold these instruments, the patient can be brought to perform a number of useful activities which make him conscious of the value of the stump, and improve his morale by giving him some freedom of action.

3. GYMNASIUM OR WALKING TRAINING SCHOOL

When the sutures have been removed and the stump has cicatrised, the patient will pass to the second stage of rehabilitation in the gymnasium, or walking training school.

The exercises now to be performed are classified under: (*a*) general curative exercises, and (*b*) exercises to restore muscle tone to the stump.

The exercises detailed and equipment required therefor in these and following sections on training are merely examples of an exercise scheme and are included as suggestions, any of which can well be developed and improved upon.

(*a*) The general curative exercises are performed both by arm amputees and leg amputees, and are designed to restore the general physical tone, to strengthen muscles weakened by lack of exercise, and to mobilise joints stiffened by inactivity and by certain bad postures resulting from the use of crutches and wheel-chairs.

It is desirable that amputees should be placed in one of the following groups when performing these exercises : children up to 15 years of age, amputees of 15 to 35 years of age, and amputees of more than 35 years of age. No further division is required, provided that the capacity of older patients to perform the exercises is watched, and that no exercise continues for more than a few minutes without a break.

The need for training therapy of this kind has been made clear by the fact that a great number of older civilian patients have been trained in this way with advantage. In contrast to ex-Servicemen, many civilians were in poor physical condition before the amputation, and when they were fitted with an artificial limb without any previous toning-up process they found the wearing of an appliance very painful and exhausting.

After the first general remedial exercises detailed in Appendix 1, the patients, seated on mattresses, perform exercises with medicine balls. (See Plate I (*b*).) It is found that not only are medicine balls good for physical training, but competitions can be organised between patients, grouped in teams, who pass the ball quickly from one to another. It is considered that this exercise is good for stimulating mental reactions which, particularly in double amputees, have been blunted by long hospitalisation.

Also it is felt that every time the spirit of competition and humour is introduced into physical training, morale improves and training proceeds more rapidly and with greater enthusiasm.

Finally, it is important that the instructors undertaking these duties are chosen carefully for their personality and ability to secure the cooperation of patients.

(*b*) Exercises for muscular rehabilitation of the stump. (See Plate VI (*a*) and (*b*).) These exercises are intended to make the stump capable of directing and moving an artificial leg. In the case of above-knee amputations, the muscles of the stump that require to be developed are the adductors, the extensors of the hip and the abductors, so that they may be able to counterbalance the most powerful flexing muscle, that of the ilio-psoas, which has not been cut, and which, without some counterbalance, is generally stronger than necessary.

As soon as the thigh stump is healed and the patient is allowed up on crutches, he will go to the physiotherapy department or walking training school, where apparatus is fitted and used as follows. A piece of timber 12 feet by 6 inches by 2 inches (3·60 m. by 15 cm. by 5 cm.) is fixed horizontally to the wall 4 feet (1 m. 20) above ground level. To this is fitted a series of pulley wheels, 3 feet apart. A piece of blind cord 9 feet (2·70 m.) long passes over each pulley; to one end is attached a sand-bag weighing 5 pounds (2 kilos) to commence with, the weight later being increased to 17 pounds (7 kilos). To the other end is attached a canvas stump sling. A handrail is situated at such a distance from the wall that when the sling is attached to the stump and the patient is resting his hands upon the rail, the sand-bag is just clear of the floor. With the patient standing facing the wall, extensor exercises are commenced, adductor exercises being performed when he stands sideways to the wall. Two exercise periods of twenty minutes each daily, continued for at least a week, will re-develop the stump muscles sufficiently for limb wearing. It may well be that a design of apparatus different from that described above has been, or will be, evolved which may prove equally, if not more, efficacious in achieving the desired result.

The need for re-educating of the adductor and extensor muscles is determined by the use to which the stump is put when the patient is walking on an artificial limb supplied for a thigh amputation.

When he is standing at attention on an artificial limb the adductor muscles must be contracted to prevent the limb from breaking away at the hip. When he takes a pace with the artificial limb the latter must be carried directly forward in the adducted position, otherwise a circumducted gait will result. When the heel of the artificial limb touches the ground at each pace the artificial knee is slightly flexed; to produce extension which is necessary in order to prevent the limb giving way beneath the patient, the extensor muscles of the hip come into action and produce extension of the knee. The use of the extensors of the hip is again essential when a patient is ascending or descending stairs.

The apparatus described above is adaptable for the development of the quadriceps in below-knee cases.

Exercises can be done by out-patients in their own homes. For thigh stumps, a home-made sling, a blind-cord and a flat-iron will serve, the cord passing over the back of the chair upon the seat of which someone is sitting. Concurrently, exercises should be given for strengthening of the erector spinae and abdominal muscles before the limb is supplied.

When the patient has completed the general curative exercises and the exercises of the stump muscles, he and his stump are ready to overcome the fatigue connected with the wearing of an artificial limb, and the next step in rehabilitation can commence.

IV. Training in the use of the Artificial Limb

1. WALKING TRAINING

In conjunction with every centre for fitting artificial limbs, facilities should be available for training in walking. At times, it has been said that training in walking could form part of the service of all hospitals having a physiotherapy service, but it is valueless unless certain conditions are observed.

First it is necessary that the training centre for walking forms part of an Appliance Centre, and is in direct contact with the makers of artificial limbs.

The reason for this is that during the first days that the patient begins to wear the artificial limb regularly certain changes tend to appear in the shape of the stump. Each change should be immediately dealt with by the fitter of the artificial limb by making the requisite adjustments in the socket, without which the stump could be seriously injured. In addition, some modification in the suspension and alignment of the limb may become necessary during the first stages of walking and only the fitter or maker of the limb is capable of making these adjustments.

In the second place, the staff, physiotherapists and others employed by the general hospitals, have neither the skill nor the technical knowledge required to teach amputees to use an artificial limb. The instructor in walking, who should preferably be a person specialising in medical gymnastics, will need to be given thorough training in matters affecting the design and main functions of the various types of artificial leg that are supplied. Moreover, it is preferable for amputees to be trained in groups or classes.

If at the time of establishing new Appliance Centres these could be set up alongside or within the framework of hospitals specialising in amputations and with specially trained staff, even better results might be obtained.

Instructors need not be amputees themselves, and may be male or female. In either case they should receive full instruction.

2. SUGGESTIONS FOR EQUIPMENT REQUIRED FOR A SCHOOL OF WALKING TRAINING

In this equipment simplicity should be insisted on—complicated equipment is useless.

Gangways for walking are necessary for adults, children and double-thigh amputees. These gangways can be constructed with uprights of tubular metal, but the hand-rail at the top should be of polished wood.

When using a hand-rail of tubular metal it has been found that at certain times of the year the cold of the metal hand-rail can induce muscular spasms in elderly patients suffering from cardiovascular disorders.

The total height of the hand-rail from the floor is 33 inches (82·8 cm.); the width between the outer edges of the hand-rail 31 inches (77·8 cm.). A pair of hand-rails is fixed lower down on brackets welded to the uprights in such a way that the top of the hand-rail is 21½ inches (54·5 cm.) from the floor and the width between the outer edges is 21 inches (53·3 cm.). These latter hand-rails are used by children, and amputees of both thighs using short pegs. (See Plate VIII.)

3. OVERHEAD PARALLEL BARS

These are gangways as described above, but at each end a pair of vertical wooden supports 6 feet 11½ inches (213·5 cm.) in height are fixed, connected at the top and at each end by a metal transverse bar. The inside surface of each upright is split and pierced so that the knobs can be inserted, to which are affixed hand-rails or parallel bars. These can be adjusted to heights convenient to each patient, the object in view being that when the patient walks between the bars, he keeps his arms extended above his head and slides his hands along the hand-rail. This exercise encourages balance and a straight spine. (See Plate VI (*c*) and (*d*).)

It is also necessary to have available a platform reached by steps on either side. The height and depth of these steps should vary in each set of steps. An inclined slope on which to practise walking is useful. White lines should be painted on the floor parallel with the length of the room, with distances of 9 inches and 4½ inches (22·8 cm. and 11·5 cm.) between the lines. At the end of the lines a wall mirror with a minimum height of 5 feet 1 inch (154·2 cm.) should be placed. (See Plate V.)

Several sets of wall bars and mattresses and simple wooden benches (without backs) are recommended.

A radiogramophone is an invaluable adjunct in helping to acquire a rhythmic gait, besides which music creates a pleasant atmosphere.

4. ARM TRAINING

While a leg amputee walks and desires to walk well or badly, according to his temperament, which in its turn conditions his attitude towards training, arm amputees can and frequently do secure employment which does not call for the use of an artificial arm.

While arm amputees of exceptional will power and personality frequently obtain very good results with their artificial limb without undergoing training, the average patient never gains the maximum functional efficiency from an arm appliance without having been trained in its use.

Training centres for arm amputees should not be set up, except where the number of these amputees justifies it.

Training as such should be confined to functional training, that is, amputees should be taught all the possible uses of their appliances, without attempting to impart any vocational training. All work should be practical, such as office work, drawing, shorthand, typewriting; patients should all learn to use domestic equipment, turn taps, manipulate electric light switches and use kitchen utensils. In this way arm amputees soon learn the value of an artificial arm, many of them begin to envisage the trade they could take up, and all of them acquire an independent spirit. During training of arm amputees, the equipment deemed necessary for present needs and probable future requirements should be made available to the patient. (See Plate VII (*a*).)

The period devoted to walking training and arm training should vary in length according to the individual trainee and no patient should be permitted to leave the rehabilitation centre unless the specialist considers that he is capable of using the artificial limb.

V. The Artificial Limb

1. LOWER EXREMITY AMPUTATIONS

(*b*) *Above the knee amputees*. For these the decision lies between prescribing a pylon (or temporary prosthesis) or a permanent limb.

Originally pylons were prescribed in order to shrink the stump and so save several new sockets on the permanent limb. Since the bandaging method already described was introduced, pylons are now rarely used for that purpose alone.

They are recommended, however, in order to render the patient ambulant as soon as possible, since they can be rapidly constructed, whilst a permanent limb takes longer. They are also prescribed to test the patient's reaction to limb wearing in cases of doubt, or to experiment with a method of fitting.

The socket of the pylon can be made of Plaster of Paris and attached to wooden (ash) supports. Durestos (or plastic) or metal (duralumin or alclad) sockets are also used for pylons and produce an extremely light temporary prosthesis, and for below-knee pylons lap jointed steels make satisfactory joints.

It is recommended that child amputees be fitted with an artificial limb as soon as they exhibit a natural tendency to want to walk.

(*b*) *Bilateral amputation above the knee*. A pair of temporary short pylon prostheses is almost essential, in the first instance, particularly when dealing with the elderly patient.

The limb surgeon has to decide according to the age and physique of the individual whether he could, despite previous remedial exercises, be expected to withstand the exertion of wearing and controlling full length prostheses at that early stage. With very few exceptions, therefore, it is the normal practice to prescribe a pair of temporary short peg legs. These consist of sockets and peg end which extends but 7 inches (18 cm.) beyond the stump extremities, and in one country there is a more recent innovation, i.e., a short rocker ended pylon, the use of which reduces the period of walking training. (See Plate III (*e*) and (*f*) and Plate VII (*b*).)

The purpose of short pegs, or the short rockers, if they be used, is that being very short the patient quickly gains confidence and learns to balance, being put to less physical exertion through having no joints to control. Further, the short prostheses are of a great prognostic value, indicating whether the patient will, if elderly, satisfactorily control a full length leg.

The pylon will be worn as long as necessary, according to the purpose for which it is prescribed and then the permanent limb will be ordered.

The limb surgeon will decide the type of limb, metal or wood, the type of fit to be used, the method of suspension, and one of the varying types of control; he will prescribe them in detail indicating to the limb maker any special features in the stump such as flexion or other deformities, in which case he will indicate the degrees of flexion or extent of scarring to be provided for in fitting. The growing tendency to fit more anatomically shaped sockets for the thigh amputees, as opposed to the "conventional" or "plugfitting" socket should be encouraged.

The limb surgeon will base his decision in each case upon a number of factors; stump length and nature, probable occupation to be engaged in, and nature of the country in which the patient will live (urban or agricultural areas, hilly or flat country).

It happens in a proportion of elderly bilateral thigh amputees that it is inadvisable on medical and physical grounds that they should progress to the full length articulated limbs. They can be rendered ambulant by supplying a pair of permanent rocker protheses.

When necessary, the surgeon will examine the patient during the fitting stages and advise the limb maker on progress.

As soon as the limb has been made and fitted to the satisfaction of the limb fitter, the limb surgeon will again examine the patient and the limb to ensure that it has been constructed and fitted according to the prescription, failing which he will reject it, indicating in what manner it fails to meet requirements.

This examination of the new limb is the next most important function of the surgeon. If he is satisfied he will arrange for the patient to commence walking training.

(*c*) *Below the knee amputations.* For these, though pylons are made, they are rarely prescribed now.

The choice of a permanent type of limb lies between the all-wood limb and the metal limb with blocked leather detachable socket. The surgeon will decide which is most suitable according to the stump, its condition, and the use to which the limb will be put.

The next point for consideration is the site of weight bearing, i.e. on the upper heads of tibia, on partly the tibial heads and thigh, or on the ischial tuberosity; the surgeon's decision on these points will be indicated on the prescription by the type of thigh corset prescribed. Finally, suspension lies between shoulder or waistbelt suspension. On completion of the prescription the procedure is as described in (*a*) above.

2. UPPER EXTREMITY AMPUTATIONS

Artificial arms may be classified under three main functional groups which are:

working arms,
light working arms, and
dress, or cosmetic arms.

Within the three main groups of arms available there are again many detailed variations of type designed for individuals. The limb surgeon therefore requires to have a comprehensive knowledge of all the types available and the details of their various functions before he is in a position to prescribe the best type of arm for the individual case, and unless the most suitable type is supplied, the patient will not attain the optimum benefits of rehabilitation.

It is considered that young children should be fitted with a cosmetic arm before the age of five, and in any case an artificial limb should be supplied before the child commences to attend infants' school.

Artificial Hands. These are available in many varieties to suit different needs. The types in most common use are: The light plastic carrying hand: the thumb opposing the tip or side of index finger may be cable operated or merely a spring thumb operated by the other hand; the plastic hand with articulating fingers made of polythene; the wooden hand.

The rubber hand whose fingers are reinforced with copper rods is used mainly by cyclists.

Mechanical Hands. Several types of mechanical hands are made, but they are not supplied generally because they have been found to be very heavy, cosmetically unattractive and very expensive to manufacture and repair.

VI. Follow-Up and Welfare

The basic requirements of follow-up are as follows:

(*a*) Specialists should interest themselves in the patient for the rest of the latter's life. (It is unlikely that the same doctor will be able to follow a patient throughout his life.)

(*b*) Arrangements should be made so that every patient on discharge from the training school should be called for review to the Appliance Centre within three months, or earlier if a breakdown of stump is reported.

(*c*) Children should be recalled every three months or less at the discretion of the limb fitting medical officer.

(*d*) Arm amputees should be reviewed to ensure that the correct appliances have been supplied, both for work and recreational purposes.

(*e*) Consideration should be given to the supply of a duplicate permanent prostheses not less than three months after the issue of the first limb.

(*f*) Provision should be made to ensure the maintenance of prostheses in good fit and repair. A postal repair system under which the patient need not attend the centre if only mechanical repairs are needed, is an example. A mobile repair and fitting shop may, under certain circumstances, provide a valuable repair service and is an example of another means of ensuring the maintenance and supply of limbs in remote districts.

(*g*) Provision should be made for the continuing supply, as requisite, of limb accessories such as stump socks, arm mitts, gloves, etc.

(*h*) The patient should be made to feel that his Appliance Centre is, for the future, his guide and friend for all matters relating to his stump and prosthesis.

APPENDIX 1

General Remedial Exercises

The equipment needed to perform the exercises that are recommended is very simple indeed. All that is required is an appropriate number of benches, with or without backs, mattresses and some medicine balls of various sizes and weights.

The following exercises to be performed on a mat are the first given, and last about 45 minutes a day, including periods of rest. For older patients, longer rest periods are indicated. The exercises should be given over a period of 7–10 days.

Informal activity: Free passing, using medicine ball.

Sitting upright: Hands resting behind back, head turning left and right alternately.

Sitting: Shoulders raise and lower (shrugging).

Sitting: Hands on hips, trunk and head turning left and right alternately.

Sitting: Arms stretched sideways, small circles backwards.

Sitting: Arms abducted, elbows flexed, head and trunk turning with alternate arm flinging sideways.

Lying on back: Stumps fixed, head and trunk slowly raise and lower.

Lying prone: Stumps fixed, head and trunk slowly raise and lower.

Lying on side: Flex stump forward and extend backwards, concentrate on backward movement and so ensure full extension.

Lying prone: Hands on mat in line with shoulders, arms stretch and bend alternately.

In performing the above exercises patients gradually progress to a stage where they can perform the more strenuous exercises given below. These exercises are carried out over a period of seven days, for one hour a day, including breaks.

Sitting upright: Hands resting behind on mat, head rotating loosely three times left and three times right.

Sitting: Raise shoulders and rotate backwards and change to forward movements.

Sitting: Arms abducted, elbows flexed, two backward presses to arms, flinging forward and sideways.

Arms abducted, elbows flexed, head and trunk turning with alternate arm flinging, sideways and extended.

Strengthening Group (using medicine ball)

Back to back in pairs one yard apart, head and trunk turning, pass ball to partner.

Sitting facing in pairs, ball held at chest, throw ball forward to partner.

Ball held forward in left hand, place right hand on top of ball, take ball back to right shoulder and push forward to partner with right hand, repeat with left hand.

Stick exercises (with ordinary walking stick)

Stick held forward, hands pronated, rotating stick forwards and backwards.

Stick held forward, head and trunk turning with stick swinging sideways.

Stick held forward, keeping arms straight, raise arms and stick upwards, overhead and press backwards four times.

Repeat the exercises "lying on side, flexing stumps", etc., and "lying prone, hands on mat", etc., with resistance.

APPENDIX 2

Walking Training Exercises

The basic principles of training in walking include teaching balance, strengthening the muscles that support the weight, gaining confidence in the artificial limb and acquiring the ability to walk with as natural a gait as possible, and to perform all the actions related to walking, including falling and getting up again confidently, so that when the patient resumes his normal existence at home and at work, he does not find himself having to perform movements with the use of his artificial limb that he has not practised under the guidance of the training school.

A. SINGLE AMPUTATION

1. *Balancing Exercises*
Using the Overhead Parallel Bars

(*a*) Stand within the rails, with arms extended above the head and hands gripping the overhead bars. Take the weight first on the good leg then on the artificial, gradually reducing the weight borne upon the hands.

(*b*) As above, but marking time, raising each leg in turn well above the floor, and gradually extending the period during which each leg is raised. In a short time the patient will be touching the overhead rails but lightly, and finally can perform the exercise without touching the rails.

(*c*) When the patient has mastered the above exercises, he progresses from marking time to walking with the Overhead Parallel Bars rack, for which he uses the Kick and Mark system, sliding the hands lightly along the overhead bars as he walks. Start with the artificial leg slightly behind the other, swing it forward freely with the stump, bringing the heel sharply to the ground, and extend the artificial knee by pressing the stump to the back of the socket.

2. *When confidence is gained he will leave the O.P.B. rack and commence exercises on the open floor, using two walking sticks.*

(*a*) Standing erect, commence arm swinging exercises, forward, sideways and upwards, holding the sticks by the handles.

(*b*) Marking time, using two sticks.

(*c*) Progression walking with the "Kick and Mark" exercise.

(*d*) Walking between two lines 9 inches (22·8 cm.) apart, painted on the floor and facing a wall mirror. Take care to ensure that the pace with the artificial leg is no longer than with the natural leg.

(*e*) As in (*d*) above, but to slow-foxtrot time to music.

(*f*) As confidence is gained, use exercise (*e*) with patient holding the sticks in the middle and swinging the arms freely forwards.

(*g*) With progress, the patient should now walk between two lines 4½ inches (11·5 cm.) apart.

(*h*) Turning. On arriving at each end of the painted lines, turning should be practised. With a right amputation and turning to right, pivot upon the artificial heel. For left turn, pivot upon the good foot. Regardless of any instruction, patients frequently develop styles of their own for this and other special exercises, and this is of no consequence, provided that the patient has complete confidence in the style adopted.

(*j*) Sitting down. Approach the chair from the front and judging the distance with practice, arrive opposite the chair with the good leg forward—pivot on the heel of the good leg toward the artificial leg and sit.

(*k*) Stairs. Ascend with the good leg leading, on lifting the artificial leg to the next stair, press stump to back of socket to ensure extension of knee before taking weight upon it. For descending, lead with the artificial leg, ensuring full knee extension in taking weight on the limb on the stair below.

(*l*) Arising from a fallen position, lead with the good leg, pushing upon the stick if carried.

(*m*) Picking up objects from the floor, take all the weight on the good leg, with artificial leg to the rear and flex both knees.

For amputations below the knee the above exercises (*h*) to (*m*) will be carried out normally, no special directions being necessary.

Concurrently with the above exercises, the following should be carried out, for the further development of balance, physical development and chest expansion.

3. *Exercises using an upright wooden chair*

(*a*) Stand behind the chair in such a position that if right leg is artificial the left leg is in line with and behind the left back leg of the chair, and vice versa. Grip the chair rail with the left hand and with walking stick in the right hand swing the artificial leg forwards and backwards in a straight line, no circumduction to be allowed.

(*b*) As in exercise (*a*) only with each forward and backward swing, press the stump and limb as far as possible.

(*c*) Standing squarely behind the chair, place both sticks upon it and balance alone with arms swinging freely, backwards and forwards, sideways and in a circle.

(*d*) As in (*c*), arms across the chest, elbows in line with the shoulders, perform a series of backwards presses with the elbows and fling the arms sideways.

(*e*) As in (*c*), standing well back from the chair, place both hands upon the top rail, bend the elbows and lower the body till the chin reaches the top rail. In this position carry out hip extensor exercises with the artificial limb and then rise to the erect position, extending the elbows.

(*f*) With a stick in one hand, the other grips the top rail at centre, lifts the chair forwards and sideways alternately to the greatest possible extent. Repeat with the opposite hand.

4. *Diversional Activities which lend interest to Training and further the Development of Balance and Confidence*

Dart playing
Table tennis
Indoor hockey with walking sticks and soft ball
Dancing
Golf and clock golf.

B. DOUBLE AMPUTATIONS

The exercises detailed in this section are for those who have suffered amputation of both legs and are wearing a pair of artificial legs. The exercises described are suitable for any combination of amputation unless otherwise stated.

1. *Exercises using overhead Parallel Bars, etc.*

(*a*) The patient stands within the Overhead Parallel Bars with his hands extended above his head, gripping the top rails. He develops a sense of balance and can soon take less weight on the arms and at the same time accustoms the weight bearing tissues to taking pressure. Attention must be paid to erectness of stance.

(*b*) When able to balance, swing the arms forwards, sideways and upwards.

(*c*) Repeat exercise (*b*) outside the O.P. Bars, holding a walking stick in each hand.

2. *Chair Exercises, using an upright wooden chair*

(*a*) Stand behind the chair with the left limb in line with the right leg of the chair. Grip the rail of the chair with the left hand and use a walking stick in the right.

Swing the right leg forwards and backwards in a straight line. Repeat exercise for the other leg by changing position behind chair.

(*b*) Position as for (*a*). Raise the leg forward with two forward presses and then backwards with two backward presses, repeat for other leg.

(*c*) Kick and Mark exercise, only for those with above-knee amputation. Standing as in (*a*), place limb to rear, swing freely forward bringing the heel sharply to the ground causing full extension of the artificial knee joint. Repeat with the other leg.

(*d*) Standing behind the chair, place both the sticks upon the chair and balance with arms swinging freely, backwards, forwards, sideways and in a circle. This is not only good for breathing but for teaching balance and confidence.

(*e*) As in (*d*). Arms bent across chest, elbows in line with shoulders. Two backward presses of the elbows and then fling arms sideways.

(*f*) As in (*d*). Standing well back from chair, place both hands upon the top rail—bend elbows till chin reaches top rail—extend elbows. Whilst doing this carry out hip extension exercises with legs alternately.

(*g*) As in (*d*). Arms crossed over chest, fling arms sideways and then upwards to full extent.

(*h*) A stick in one hand, the other grips top rail of chair—raise the chair as much as possible forwards and sideways to given count—repeat with opposite arm.

3. *Special Exercises*

(*a*) *Picking up objects from the floor.* All weight to be taken on one stick—lower the same shoulder as stick hand to the top of the handle—slide the other hand down the shaft of the stick, then free it and pick up the object.

With below-knee amputations the knee should flex.

(*b*) *Correct sitting.* Approach the chair from the front—turn sideways to it, placing the right hand upon the back top rail, with the left stick to the rear. Turn, allowing the artificial knees to flex, taking weight upon chair back and stick and lower gently to the chair. Not applicable to those who have both their natural knee joints.

(*c*) *Getting up from sitting position.* Place the left stick in front a little—turn body slightly to the right on the chair seat. Extend the left leg to just behind the stick and brace back. Place right hand on chair seat and push up with both hands towards the extended limb till upright. If the patient is stronger in the right stump reverse the above. Not applicable to those having one or both natural knee joints.

(*d*) *Regaining an upright position after falling.* (Double above-knee.) Lying prone, place the sticks on either side of the body with handles in line with the hips. Bringing arms to the front support position, straighten them and push back till the kneeling position. Extend the limb which has the strongest stump slightly sideways and outwards. Push with the arms in the direction of the extended limb, moving the hands backwards at the same time. Extend the opposite limb till both feet are firmly on the ground then pick up one stick, taking the weight on it till the other is regained and, using both sticks, regain the upright position.

(*e*) *Walking—Double above-knee cases.* "Kick and Mark" exercise using two sticks, carry the body weight forward on to the extended limb with the opposite stick forward, repeat with the other limb and stick, paying strict attention to erect carriage and adduction of limbs. Walking exercise between white lines painted on the floor in front of a wall mirror and to slow music.

(*f*) *Turning whilst stationary.* Turn trunk to left and right alternately, reaching with sticks as far behind as possible.

With both sticks forward and right leg forward, place sticks in left turning position and pivot of feet to the left. About turn—two movements. To the left—right foot forwards, sticks to the left and turn—left foot backwards, sticks to left and bring right foot forwards.

(*g*) *Turning whilst mobile.* To the right. Turn with the right foot forward, at the same time swinging the left leg and sticks to the right.

(*h*) *Ascending stairs for double above-knee amputations—where handrail is provided.* Using one stick grasp the rail with the hand opposite to the strongest stump. Place limb with strongest stump on stair fully extended—place stick to the rear. Push on stick and pull on rail till weight is taken on leading limb and carry other leg forward to stair.

For one above—and one below-knee—lead with the below-knee.

(*i*) *Descending stairs—handrail provided.* Place one hand on rail and one stick forward on lower stair. Place one limb with heel clear of stair—take weight on stick and rail—bend opposite leg which lowers patient to lower stair.

(*j*) *No handrail.* Approach stairs and turn sideways. Place one stick on lower stair (that of leading leg) with opposite stick to the rear. Place leading leg backwards a little, take weight on sticks, bend other knee and ease weight on to leading leg, swinging other leg to lower stair.

For one above and one below. Use one stick and lead with above-knee leg bending the below-knee leg.

4. *Standard test to be taken by above-knee amputations on completion of course of training (double and combinations of doubles)*

(*a*) Correct carriage (walking with a book balanced upon the head).

(*b*) Correct gait.

(*c*) Turning in various directions, stationary and whilst mobile.

(*d*) Ascending and descending stairs.

(*e*) Stepping over obstacles whilst stationary and mobile (a development of the "marking time" exercise).

(*f*) Correct sitting down and rising from sitting position.

(*g*) Picking up objects from the floor.

(*h*) Rising from a fallen position.

(*i*) Balancing with alternate legs.

(*j*) Balancing with feet together whilst swinging arms.

APPENDIX 3

Surgical Technique of Amputation

Amputation having been found necessary, a decision must be reached as to the appropriate level at which it should be performed.

The decision upon this point is influenced by the cause and nature of the amputation, that is, whether it be of an emergency or of a definitive nature.

A. EMERGENCY AMPUTATIONS

In the case of emergency or life-saving operations the level at which the amputation is performed should be the lowest at which the underlying purpose of the operation will be fulfilled.

Should the resultant stump, when healed, prove unsatisfactory for future limb fitting and wearing, an operation for revision of stump should be performed later, when consideration should be given to the production of the type of stump such as is provided when definitive amputations are performed.

The optimum levels of amputation are given in Appendix 4 and the maximum and minimum lengths of stumps recommended are given in Appendix 5. In performing definitive amputations upon children the bone section should be at the lowest possible level. Growing epiphyses should be preserved whenever possible and the length of flaps should be such that there is no tissue tension over the cut end of the bone.

If the best results are to be obtained from both surgical and prosthetic angles there are certain details of technique which are recommended for consideration.

1. *Lower Extremity*

General

(*a*) The importance of accuracy in the cutting of flaps, the rounding off of all corners or angles and the neatness of alignment of flaps when suturing.

(*b*) The flaps should contain only sufficient fat and connective tissue with their blood vessels, to ensure their nutriment.

(*c*) The securing of as complete a haemostasis as possible at the time of operation and avoidance of haematoma formation.

Specific

(*a*) For a thigh amputation, the antero posterior flap method is recommended, with the anterior flap being slightly the longer in order to position the scar transversely and posteriorly.

(*b*) When performing an amputation through the thigh, unnecessary traumatisation of the sciatic nerve should be avoided in order to minimise the risk of development of painful neuromata and phantoms. Traction, ligaturing of nerve trunk and crushing are not recommended.

(*c*) In a thigh amputation the sewing of the deep fascia over the stump end is recommended.

(*d*) For amputation through the leg, equal anterior and posterior flaps should be cut; the equilateral flap method is not recommended.

(*e*) In performing bone section of the tibia the anterior inferior border should be bevelled off and the fibula sectioned 1 inch (2·4 cm.) higher than the section of the tibia.

(*f*) It is not customary to remove at time of bone section the periosteum or bone marrow.

2. *Upper Extremity*

For all amputations of the upper extremity, equal anterior and posterior flaps are recommended in order to provide a terminal transverse scar.

APPENDIX 4

Optimum Sites for Amputations

1. *Lower Extremity*

The delegates from Belgium, France, Netherlands and the United Kingdom agreed unanimously that the optimum sites for amputation of the lower extremity are as follows:

Thigh: (10–12 inches) 25 to 30 cm. from the top of the great trochanter.

Leg: (5½ inches) 14 cm. from the internal central line of articulation.

With regard to other amputations and disarticulations:

Disarticulation at the hip. Not recommended by the four national delegates, other than in exceptional cases.

Gritti Stokes. Not recommended by any of the four delegates, but there are some surgeons who still favour this operation.

Disarticulation at the knee. This was not recommended by Belgian delegates; regarded as of doubtful value by the French and Netherlands delegates, but favoured for children and old persons by the British delegation.

The Syme. This is regarded as of doubtful value by the Belgian, French and Netherlands delegates, whilst the British delegates favoured it in special cases.

Pirogoff. The French and British delegates did not recommend this operation, whilst the Netherlands delegates regarded it as of doubtful value.

Chopart. This operation was not recommended by any of the delegates, particularly in view of the difficulty of production and fitting of limb.

Lisfranc. This was not recommended by Belgium, France or the British delegates, whilst the Netherlands delegates regarded it as of doubtful value.

2. *Upper Extremity*

Delegates from Belgium, France, Netherlands and United Kingdom agreed unanimously that the optimum sites for amputation of the upper extremity are:

Above the elbow: (8 inches) 20 cm. from the acromion.

Below the elbow (7 inches) 18 cm. from the tip of the olecranon, or leaving sufficient room at the end of the stump for fitting a wrist mechanism.

With regard to other amputations and disarticulations:

Disarticulation of shoulder and elbow were not recommended by any delegate.

Disarticulation at the wrist was regarded as useful in special conditions.

Hand. All the delegates agreed that the maximum amount should be preserved, provided there is no cicatricial shrinkage and sensitivity is preserved.

APPENDIX 5

Minimal and Maximal Lengths of Stump

The Thigh

Minimal: 6 inches (15 cm.) from the trochanter or
4 inches (10 cm.) from the adductor tubercle.

Maximal: 12 inches (30 cm.) from the trochanter.

The Leg

Minimal: 2 inches (5 cm.) from the central line of articulation at the knee.

Maximal: 6 inches (15 cm.) from the central line of articulation at the knee.

The Upper Arm

Minimal: ¾–2 inches (2–5 cm.) from the lower border of pectoralis major.

Maximal: 3½ inches (9 cm.) from the central line of articulation at the elbow.

The Fore-arm

Minimal: 3½ inches (9 cm.) from the olecranon; in some favourable cases may be slightly less.

Maximal: 8 inches (20 cm.) from the olecranon, but in special circumstances may be as low as the wrist.

Note: The above maximum and minimum measurements should be regarded merely as indications.

APPENDIX 6

Appliances

There are many different types of appliances for use with the artificial arm which have been evolved, either for general utility purposes or to suit the needs of those engaged in special occupations.

Broadly, these may be grouped under the purposes for which they are designed and comprise the following:

Appliances for

1. Personal toilet and domestic needs
2. General office work and draughtsmanship
3. Hobbies
4. Use in engineering and mechanical pursuits
5. Use in the electrical trades
6. Carpentry
7. Building industry
8. Painting and decorating
9. Work on the land
10. Chemical and other scientific pursuits
11. Car driving

Some of the appliances available are capable of performing the same function, and when this is so, the patient will choose whilst undergoing Arm Training, that which best suits his purposes; all are of value to some patients.

Though there are many types, no one patient should require, on average, more than four appliances. Those for personal and domestic needs and perhaps for hobbies should be issued with the artificial arm, whilst those used for vocational purposes can be selected and prescribed during or at the conclusion of arm training.

Apart from personal toilet and domestic appliances, working appliances are not usually suitable for use with a purely cosmetic arm which is not designed for work, excepting that in the case of women and children, lighter varieties of working appliances made of duralumin should be provided.

APPENDIX 7

Progress and Research

The fitting of artificial limbs, their design, alignment and function, is in a constant state of evolution and cannot remain static. Whilst most limb makers, in their own interest and that of their patients, carry out research and develop ideas, many of them have not the resources to undertake research, and when new ideas are developed by individual limb makers they are usually protected by patents and the results are not available to all patients.

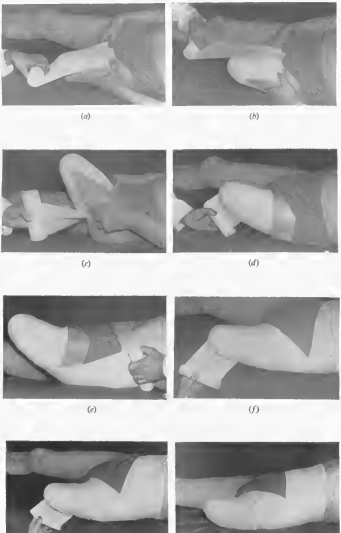
It would be desirable for the national organisation responsible for the supply of prostheses to establish, parallel to those of private contractors, its own Research Department, because such an organisation has greater resources and a wider field upon which to draw for ideas than any one limb maker, and the results of such research can be made available to all.

(4802) (69922) Wt. 2138/9147 K21 7/57 Hw.

(*a*) Entrance to the Limb Fitting Centre

(*b*) Remedial exercises using a medicine ball

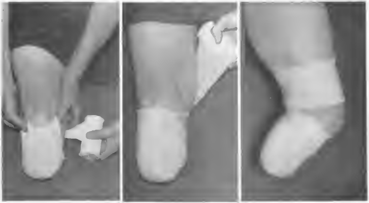
PLATE I



(a) (b) (c) (d) (e) (f) (g) (h)

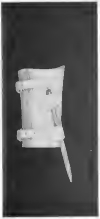
(a)–(h) Compression bandaging of an above knee stump

PLATE II

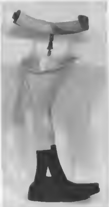


(*a*) (*b*) (*c*)

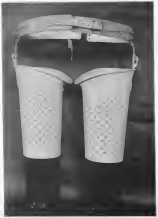
(*a*)–(*c*) Compression bandaging of a below knee stump



(*d*) Adjustable leather gauntlet as used for writing

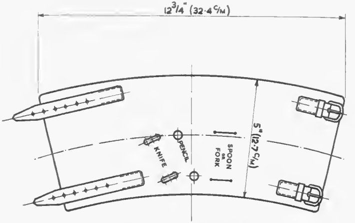


(*e*) Rocker Peg Leg for bilateral above knee amputees

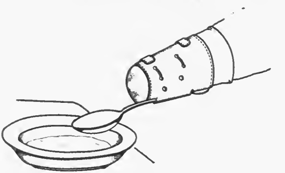


(*f*) Elephant Peg Legs for bilateral thigh amputees

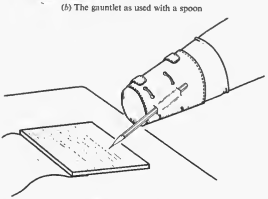
PLATE III



(*a*) Dimensions of an adjustable leather gauntlet

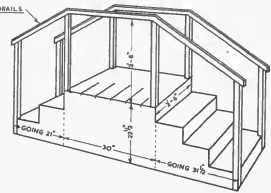


(*b*) The gauntlet as used with a spoon

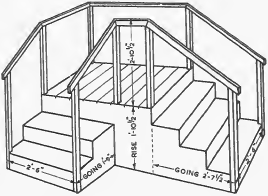


(*c*) The gauntlet as used with a pencil

PLATE IV

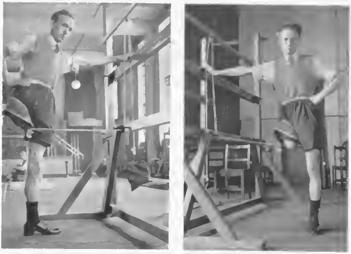


(*a*) A platform for fitting along a wall in the walking school



(*b*) A platform for fitting in a corner in the walking school

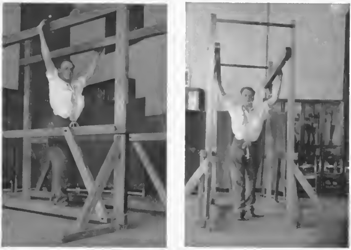
PLATE V



Stump muscle exercisor

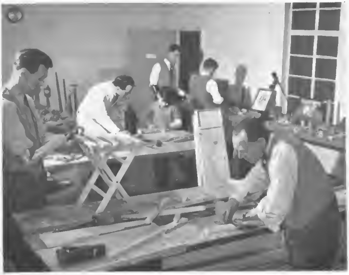
(*a*) as used for developing the power of abduction

(*b*) as used for developing the power of adduction

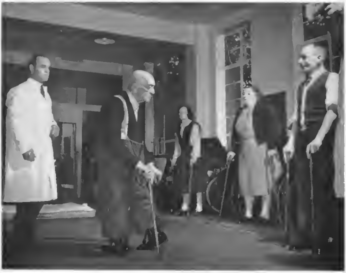


(*c*), (*d*) Overhead parallel bars used to assist in providing an erect stance and preventing lordosis

PLATE VI

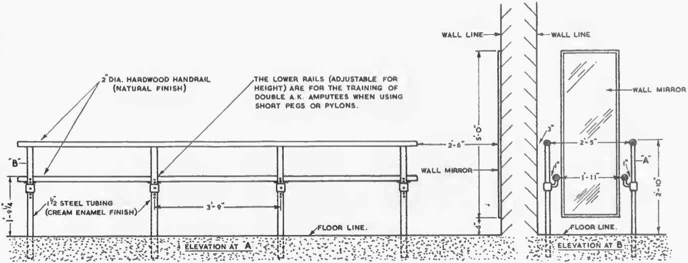


(*a*) The Arm Training School



(*b*) Rocker Peg Legs in use

PLATE VII


2" DIA. HARDWOOD HANDRAIL (NATURAL FINISH)
THE LOWER RAILS (ADJUSTABLE FOR HEIGHT) ARE FOR THE TRAINING OF DOUBLE A.K. AMPUTEES WHEN USING SHORT PEGS OR PYLONS.
"B"
1'-9¼"
1½ STEEL TUBING (CREAM ENAMEL FINISH)
3'-9"
2'-6"
FLOOR LINE.
ELEVATION AT A
WALL LINE
5'-0"
WALL MIRROR
6"
WALL LINE
WALL MIRROR
3"
2'-5"
1"
1"
1'-11"
"A"
2'-10"
FLOOR LINE.
ELEVATION AT B

Specification of the Walking Rails and Wall Mirror

PLATE VIII